

Asteroidal Bulk Densities

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Bulk densities provide important information on the current physical structures of asteroids and provide clues as to the conditions under which they formed. Given a reliable asteroid mass and volume, its bulk density can be computed; by matching this asteroid bulk density against those of potential meteorite analogs, one can determine the likely porosity of the asteroid in question. An asteroid's mass can be determined by analyzing the ground-based astrometric observations of another less massive asteroid before and after it makes a close approach (or multiple approaches) to the more massive asteroid whose mass is to be determined. While this technique has been used successfully to determine the masses of twelve asteroids to date, it is difficult to accurately determine their bulk densities because most of these asteroids do not have accurate determinations for both their mass and volume. Using Space Telescope observations of asteroid 45 Eugenia and its satellite, Merline et al. (1999, *Nature*, 401:565) estimated the volume, mass and bulk density (1.2 g/cm^3) of this asteroid with a F-type (C-type subclass) spectral classification. Belton et al. (1995, *Nature*, 374:785) used the Galileo spacecraft images of asteroid 253 Ida and its satellite to estimate the mass, volume and bulk density (2.6 g/cm^3) of this S-type asteroid. During the NEAR spacecraft flybys of C-type asteroid 243 Mathilde and the subsequent flyby and rendezvous of the S-type asteroid 433 Eros, the bulk densities were estimated to be 1.3 and 2.6 g/cm^3 respectively. One preliminary interpretation of these results could be that C-type asteroids may be of a rubble pile construction with significant ($>50\%$) porosity and with surprisingly low bulk densities ($\sim 1.3 \text{ g/cm}^3$). S-type asteroids are more likely to be solid rocky bodies (10-30% porosity) with bulk densities similar to that of the Earth's crust (2.6 g/cm^3).